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# USSR: Analysis of Trends in Oil Production in Tyumen' Oblast

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Supplement to SOV 86-10051

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# **USSR: Analysis of Trends in Oil Production in Tyumen' Oblast**

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**Supplement to SOV 86-10051**

This supplement was prepared by  
Office of Soviet Analysis

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Comments and queries are welcome and may be  
directed to the Chief, Economic Performance  
Division, SOVA

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**Contents**

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	<i>Page</i>
Oil Production in Tyumen' Oblast	1
The Production Base: Old and Getting Older	1
The Neglect of Exploration	2
Overworking of the Major Oilfields	4
Equipment and Well-Maintenance Problems	5
Infrastructure	7
Why Is Oil Production Up in 1986?	7
Oil Production From Regions Outside Tyumen' Oblast	8

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## USSR: Analysis of Trends in Oil Production in Tyumen' Oblast

### Oil Production in Tyumen' Oblast

#### The Production Base: Old and Getting Older

Tyumen' oilmen attained the enormous production increases of the 1970s by rapidly developing a small number of large and highly productive fields. Production from just three giant fields—Samotlor, Mamontovo, and Fedorovo—accounted for nearly 70 percent of the output from Tyumen' in 1975 (see foldout map). In 1980, production from Samotlor alone accounted for about half of the region's output and about one-fourth of national production.

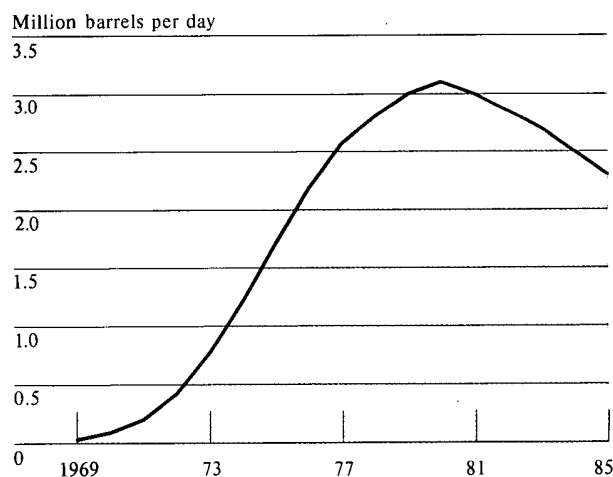
During 1981-85, despite the introduction of about 13 new oilfields—bringing the number in production to about 50—most of the region's output still came from a handful of the oilfields brought on line in the late 1960s and early 1970s.

Output from nearly all of these major fields is declining.

We estimate that the Soviets have produced over 11 billion barrels of Samotlor's 15-20 billion barrels of recoverable reserves (see figure 1).<sup>1</sup> Output from the second-generation West Siberian fields—such as Fedorovo, Mamontovo, Lyantor, Agan, and Severo-Var'yegan—is beginning to decline. By the end of the decade, production from these fields will probably decline by an additional 2 million b/d.

Offsetting the production losses from these aging fields is requiring the development of an increasing number of small fields that are far less productive and

**Figure 1**  
**Production History at**  
**Samotlor Oilfield, 1969-85**



Note: The area under the curve represents cumulative production of about 11 billion barrels. We estimate the remaining recoverable reserves at 4-9 billion barrels.

are located in more remote areas. During 1976-80, the average size (in terms of "explored" reserves) of newly discovered oilfields in Tyumen' Oblast was about one-eighth the average size of the fields discovered during 1961-65. This trend appears to be continuing. Reservoir quality has decreased markedly in recent years, and the new fields appear to have substantially lower well flows because of lower porosity and permeability.<sup>2</sup>

<sup>2</sup> Oil-bearing horizons in these areas were laid down at greater depths and were thus subject to more compaction, which consequently lowered the percentage of rock occupied by pore space in which oil can accumulate.

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November 1986

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Because the new fields being commissioned are not comparable in size and flow rates to the aging oilfields introduced in the 1960s and early 1970s, the Soviet oil industry has been on a treadmill, faced with the difficult task of "having to run faster to stay in place." The number of active wells is increasing sharply, but average new-well flows are falling rapidly and the annual increments to the region's production are smaller [redacted] As the drop in production from old wells increases, more of the production from new wells goes toward offsetting this drop. [redacted]

[redacted] the share of new capacity intended to offset production declines would increase from 27 percent in 1970 to an estimated 86 percent in 1985. This estimate was optimistic [redacted]

#### **The Neglect of Exploration**

The discoveries of giant West Siberian oilfields in the 1960s apparently nurtured an illusion that "golden gushers" could readily be found and added to the reserve base as needed. Consequently, the exploration effort in this region was accorded a low priority during the 1970s. Exploratory drilling for oil in Tyumen' accounted for about 12 percent of the total exploratory drilling for oil during 1971-75 and 17 percent in 1976-80.<sup>3</sup> During the 1970s, heavy

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### *The Outlook for New-Well Flow Rates*

*In general, oil production falls when production from new wells is less than the decline in output from the older wells.*

*In 1985, production from the region declined about 240,000 b/d as output from new wells failed to compensate for declines in old wells and for "lost" production from idle wells. Because the flow rates of new wells are the principal determinant of how many new production wells need to be drilled to meet a production target, Soviet expectations of West Siberian new-well flow rates can be inferred from reported plans for drilling and production during 1986-90.*

*To forecast new-well flow rates, we examined a statistical relationship between these rates and cumulative development drilling. Development of an oil basin generally proceeds from the best prospects to the worst ones. This trend certainly has been true in West Siberia since the early 1970s, as the infrastructure has been developed and improved. A 1979 Soviet publication indicated that new fields developed after 1985 would be worse than those developed in 1981-85. By 1985, new-well flow rates were expected to be only 17 percent of the 1975 rate.*

*We believe that the sharp drop in average well flows during January-November 1985—from about 365 to 290 barrels per day—was caused in part by the comparatively low producing characteristics of the new fields brought on line.*

*The Soviets have reported that they plan to drill 130 million meters in West Siberia during the 1986-90 period—about as much as the oil ministry drilled in the entire country during the 1981-85 period. Distributing this amount over time suggests that drilling will reach 32 million meters in 1990, up from 18 million in 1985. Using our statistical relationship, we estimate a decline in new-well flow rates, from about 220 b/d in 1985 to roughly 150 b/d in 1990.*

emphasis was still being given to the older producing areas such as the Volga-Urals, North Caucasus, and Central Asia. By the mid-1970s, Soviet exploration priorities had become so lopsided that West Siberia accounted for more than two-thirds of gross additions to "industrial" reserves (a category of reserves that extends from reserves in producing fields to those in well-studied but minimally drilled fields) but only about 15 percent of the exploration drilling effort.<sup>4</sup>

Soviet press articles since the late 1970s have noted the neglect of exploration in Tyumen'. The Soviets are currently showing more concern for exploration drilling, but the emphasis on production is still dominant. After stagnating in the early and middle 1970s at 500,000 to 600,000 meters annually, exploration drilling in West Siberia surpassed 1 million meters in 1980. Plans for 1981-85 originally called for exploration drilling there to average nearly 2.5 million meters per year, but in 1981-84 it averaged only about 1 million meters.

During the late 1970s and early 1980s, a growing share of the estimated reserves at Tyumen' were from geologic structures explored with only minimal drilling. The Soviet press recently reported that some reserve estimates were made without regard to a development plan and commonly used a maximum-attainable-recovery factor based on state-of-the-art methods—some of which were not widely applied in the Soviet oil industry.<sup>5</sup>

<sup>4</sup> In general, Soviet exploration methodology skimps on deep drilling because of the high costs involved. In 1975, exploration drilling costs in West Siberia averaged 300 rubles per meter for wells averaging 2,775 meters in depth, compared with average development drilling costs of 100 rubles per meter for wells averaging 1,830 meters in depth. By 1980, the comparison was much less favorable. The average for exploration wells increased to over 445 rubles per meter for well depths of about 2,800 meters, while development drilling costs rose to 120 rubles per meter for well depths of about 2,150 meters.

<sup>5</sup> Soviet central planners probably also viewed oilfields discovered but as yet lacking infrastructure as proved reserves available for meeting short-term production targets. Without infrastructure, however, such fields are not reliable production assets. Soviet media discussions indicate acrimony on the part of oilmen because the central planners set unrealistic targets that the oilmen by hook or crook were obligated to meet.

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Despite press reports that cautioned against excessive water injection, the Soviets have in recent years continued to rely on this practice.

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In his Tyumen' speech, Gorbachev indicated that the reserves-to-production ratio for Tyumen' had fallen substantially in recent years—to a level equal to the nationwide average. Gorbachev also noted that the geologists were "in arrears" to the oilmen and that this was threatening the region's ability to raise production.

Careful control of water injection is important. Ideally, the injected water moves through the oil-bearing formations from the injection wells toward the producing wells in a broad front. But if a "finger" of water under pressure breaks through to the producing wells, the rest of the water will tend to follow this easier path. A sizable amount of oil will be left in the reservoir, and production of oil will fall rapidly. Infill drilling and pumping requirements escalate accordingly.

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#### **Overworking of the Major Oilfields**

From the beginning of the 1970s, Tyumen' oilmen faced unrelenting pressure from Moscow to increase output faster than the West Siberian oilmen thought wise—and faster than new reserves were being discovered. Tyumen' oilmen responded to the pressure from Moscow for more oil by stepping up drilling in the major fields and by maintaining reservoir pressure through raising the volume of water injected into reservoirs. In short, rather than trying to extend the life of the major oilfields, the Soviets pursued a development plan for these deposits that will probably lead to earlier onset of sharply falling production and will lower ultimate oil recovery.

Despite the need for thorough preparation and monitoring, the Soviet water injection program at some fields is notably haphazard; the press reports that metering equipment is not available at the Sutormin oilfield, and the precise volume and pressure of water being injected are unknown. The Soviets may have damaged the reservoirs at these sites by rupturing the reservoir seals and cap rock. Moreover, the water injected should be carefully treated (for removal of harmful oxygen, sulfide-reducing bacteria, and other organic matter)—and heated if necessary—to match reservoir conditions. Cold surface waters can lower oil temperatures and flow rates by raising viscosity. In Tyumen', water rates and pressures are seldom monitored, and the water supply is seldom heated or treated. More than half the water used is taken from rivers and lakes and then combined with associated connate water and underground aquifer water. This practice exacerbates the rate of oil well salt buildup and hydrogen-sulfide corrosion problems that plague downhole producing equipment.

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Development drilling in Tyumen' increased from a total of nearly 9 million meters during 1971-75 to about 26 million meters during 1976-80 and to about 68 million meters during 1981-85.

The Soviets complemented this accelerated drilling program with an intensified water injection program. In 1975, oilmen injected about 260 million tons of water into the Tyumen' reservoirs.

At most Tyumen' fields, production eventually exceeded the level required for maximizing oil recovery over the long term.

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[redacted] The result was predictable: by 1981 the cumulative oil recovery from this supergiant field was only about 30 to 40 percent of the original estimate for ultimate oil recovery. (In contrast, at Prudhoe Bay it is expected that recovery will be above 50 percent of the original estimate when output peaks in 1986-87.) As noted earlier, production from Samotlor has been falling by about 6 percent per year since 1980. [redacted]

**Equipment and Well-Maintenance Problems.** The overproduction of the Tyumen' oilfields has accelerated the decline of reservoir pressures and has led to a sharp increase in the proportion of water produced with the oil (water cut), creating a rapidly escalating requirement for pumping equipment. During 1976-85, the average water cut for these fields increased from about 15 percent to an estimated 50 percent. [redacted]

In addition to the increasing number of older wells that require pumps after failing to flow oil naturally, six out of seven new wells require pumping equipment from the onset of production. The need for an adequate supply of high-quality artificial-lift equipment is self-evident: if wells do not flow at a satisfactory rate, pumps or gas-lift systems will probably be used. Soviet pumping equipment, however, is of low quality and low reliability. Soviet rod-and-beam pump systems have the worst service record of all the artificial-lift equipment produced in the USSR. The capacity of Soviet submersible pumps—a maximum of about 1,200 b/d for the largest Soviet units—is less than half that of units purchased from the United States during the 1970s. [redacted]

Exacerbating the equipment supply and maintenance problem is the vastness of the West Siberian oil-producing region. Most of the new fields that have come on line in recent years are located much farther from the major personnel and supply bases than the

fields developed during the 1970s. The lack of adequate social infrastructure in these areas has contributed to high labor turnover. One major construction association reportedly loses 40 percent of its personnel annually. [redacted]

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Servicing wells on pump in these remote areas is more difficult and time consuming, especially in view of winter temperatures that often dip well below —18 degrees Celsius (0 degrees Fahrenheit) and the swampy condition of the terrain in the summer.

[redacted] We believe that this problem will only worsen as the Soviets move farther north to develop new fields, unless increased investment is allotted for transportation infrastructure. [redacted]

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Equipment shortages, as well as the unreliability of Soviet pumping equipment, led to a very high number of idle wells in 1985—about 20 percent of the well inventory. The failure of the machine builders and Tyumen' oilmen to prepare for the time when the "golden gushers" would cease flowing by themselves was highlighted in Gorbachev's September 1985 speech in Tyumen' and has been a central theme in media criticism. Press reports indicated that, during

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the unusually severe winter of 1984-85, idle wells at Samotlor and Var'yegan constituted 33 and 50 percent, respectively, of the well stock. Cold temperatures—combined with equipment and labor shortages—slowed the Soviet effort to service and repair idle wells.

Use of the gas-lift method of artificial lift offers not only enhanced production capability but also a substantial reduction in well-maintenance requirements in comparison with either rod-and-beam or submersible pumps. Gas lift involves the introduction of compressed gas into the fluid at the bottom of the well to lighten the column of fluid and facilitate its rise to the surface. The Soviet press reports that 30 to 40 percent fewer personnel are required to service a gas-lift system than to maintain wells using downhole pumping equipment. These advantages are offset to some extent by the demanding technical requirements for installation and operation of the equipment.

The Soviets are currently installing gas-lift systems at the Samotlor, Fedorovo, and Lyantor oilfields and plan another at Var'yegan. Installation of these systems has been behind schedule for several years. Gas-lift operations have reportedly improved in 1986.

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**Infrastructure.** The Soviet press reports that the development of infrastructure in Tyumen' is four to five years behind the level needed to support the current production effort efficiently. For example, while output from the Var'yegan oilfield was near the plan production goal in 1984, only 27 percent of the work for equipping the field was completed. This deficiency in infrastructure was a major cause underlying the field's poor performance in 1984 and 1985.

according to the party official. The corrosion of water-supply and crude-oil-gathering pipelines poses severe operational problems that affect waterflood pressure-maintenance programs and crude-oil production operations, in turn intensifying the demand for scarce labor, replacement equipment, and spare parts.

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The Politburo's recent decision to increase investment for infrastructure by 60 percent during 1986-90 is intended to address such imbalances.

#### Why Is Oil Production Up in 1986?

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Increased oil production from Tyumen' Oblast was responsible for the nationwide increment of roughly 470,000 barrels per day from December 1985 to July 1986.

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As noted earlier, most of the Soviet effort in Tyumen' during the 1980s was directed at further development of existing fields. Consequently, the pace at which new fields were brought on line during 1981-85 actually slowed. Only 13 new fields entered production during this period. In contrast, the Soviets had brought 22 fields on line during 1976-80. Gorbachev alluded to this trend in his September 1985 Tyumen' speech and called for an accelerated effort. The plan for 1985 was to bring an additional 15 fields on line, but press reports indicate that this goal was not met because of equipment and labor shortages, aggravated by the remote locations of the new fields.

The following is the yardstick against which we measure the relative contribution of well repairs and new-well commissionings to the sharp rise in output recorded in the first half of 1986: the gross addition to active capacity needed to provide the reported increment in production and offset the loss of output due to depletion during the period (estimated from the recent trend in annual depletion rates)

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While infrastructure development is behind schedule, many of the existing facilities—storage tanks, gathering lines, and water injection systems—are increasingly being taken out of service for repair because of corrosion problems. Recently, for example, the new oil minister, Vasiliy Dinkov, blamed below-plan performance on the inability of Tyumen' oilworkers to maintain oilfield reservoir pressures by waterflooding. Concurrently, a speech by the Al'met'yevsk party chief complained about the serious pipeline and equipment corrosion problems that were encountered by the Tatar and Bashkir workers assigned to Tyumen' last January. These problems allegedly prevented them from making their production quotas. The speech noted that crude-oil pipelines develop numerous leaks after only one or two years of service because of hydrogen-sulfide corrosion. In normal Soviet experience, such pipelines last two or three times as long,

The pace of well completions was roughly 25 to 30 percent above last year's level, and nearly 1,400 idle wells (wells that had been awaiting repair or pumps) returned to production. The latter factor accounted for 30 to 35 percent of the gross capacity added in Tyumen' during January-July. Press reports suggest that increased output from wells equipped with gas lift also made a substantial contribution because their flow rates are higher than the regional average.

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to output will be adversely affected by more difficult operating conditions in new, more remote fields and by the lower well flows being encountered, oil production in Tyumen' Oblast will probably level off and fall in the next year or so. [REDACTED]

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#### **Oil Production From Regions Outside Tyumen' Oblast**

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[REDACTED] the national oil production total reported by the Soviet press, we are able to chart the aggregate oil and gas condensate production from other areas. Although this residual includes production from Tomsk Oblast, output there is small (about 4 percent of West Siberia's total) and is growing only slightly.<sup>7</sup> Thus, we believe that the trend for regions outside Tyumen' closely approximates the production trend for the oil-producing regions outside West Siberia.

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During 1976-84, oil and gas condensate output from areas outside the main producing region in Tyumen' Oblast declined, on average, more than 200,000 b/d annually. At the start of 1985, aggregate output from these areas stabilized, and by midyear it had increased [REDACTED]. We cannot conclusively determine why production stabilized and then increased, but we believe that a combination of developments was responsible:

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We believe that the higher production level achieved in the first half of 1986 may not be sustainable for long. The Soviet press reports that most of the idle wells that have been returned to production required only minor repairs and that restoring the remaining idle wells to operation will be more difficult and time consuming. Moreover, as the number of idle wells is reduced to a normal level, nearly the full burden of offsetting depletion and providing any incremental production will fall upon drilling and well completions. The drilling requirement is clearly challenging.

- Output of gas condensate began at Karachaganak in late 1984. The Soviet press reports that about 20,000 b/d of condensate was produced in 1985.

- Production from the April 28 oilfield rose rapidly,

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<sup>7</sup> This residual also includes gas condensate production from the north Tyumen' gasfields, which accounts for less than 1 percent of Tyumen' output. [REDACTED]

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Because the contribution of these activities

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- With about 150 wells drilled to the condensate-producing formation at Urengoy, a substantial amount of production could have come on line almost simultaneously when the pipeline and processing plant were finally completed. It appears likely, however, that the pipeline and plant were not operational until May 1985. [redacted]

relatively topheavy in personnel and brigades. If this were the case, the initial effect of a reduction in resources would be minimal. However, a continued drawdown in resources may eventually lead to production outside Tyumen' falling at a steeper pace.

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Production from regions outside Tyumen' began to decline again by mid-1985. The average annual rate of decline [redacted] however, does not appear to be as steep as that experienced previously. It is too early to tell whether the decline will continue at this rate. These regions are continuing to send labor and equipment to Tyumen'. Some data for well-repair brigades in 1984 indicate that these regions were

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**Figure 6**  
**Oil- and Gas-Producing Regions in the Soviet Union**



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